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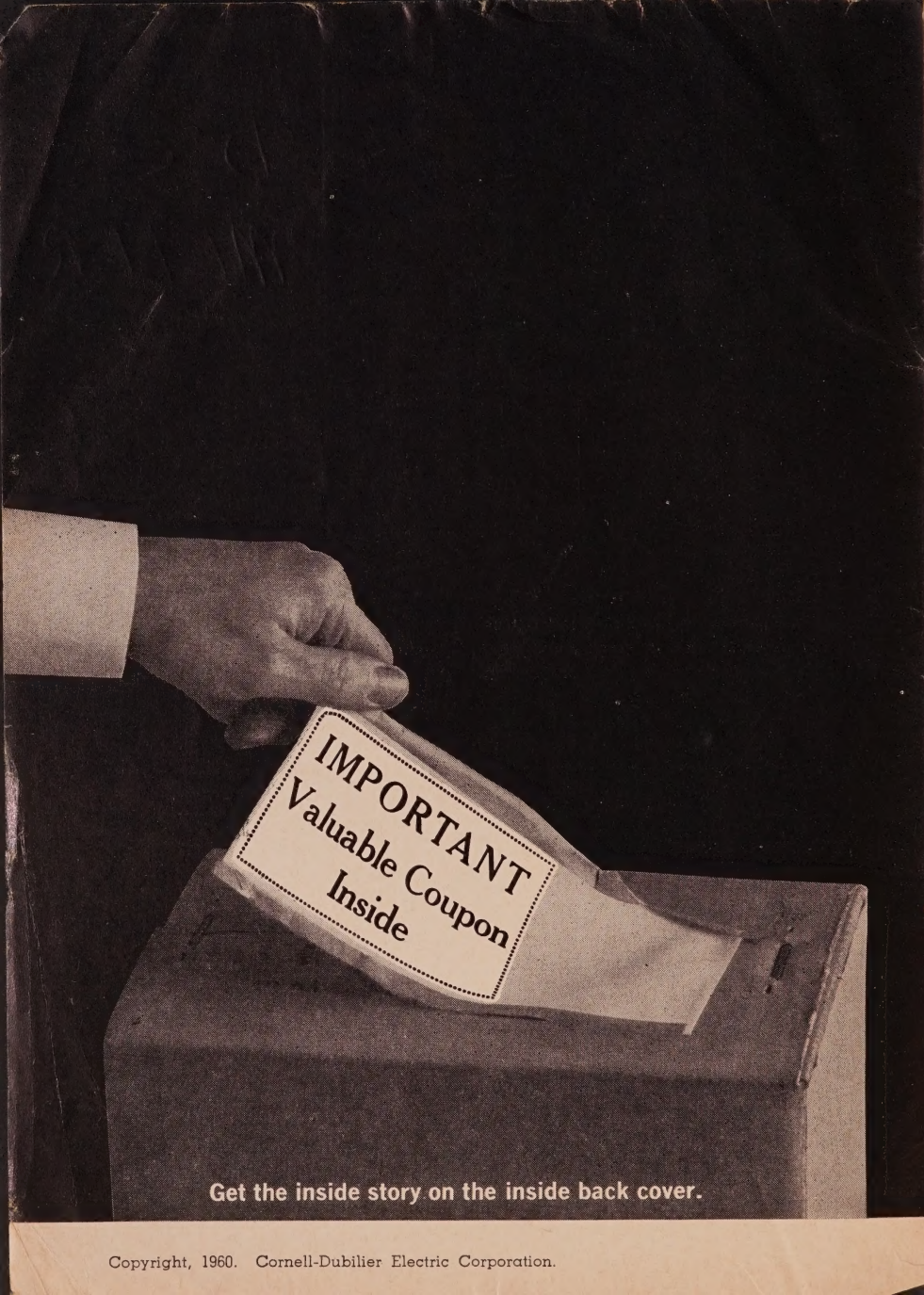
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50th Anniversary 1910-1960

A black and white photograph showing a person's hand holding a cardboard box. The box is tilted, and a label is visible on its side. The label has a dotted border and contains the text 'IMPORTANT Valuable Coupon Inside'. The background is dark and textured.

IMPORTANT
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Inside

Get the inside story on the inside back cover.

D-C METER PROTECTION

Direct-current meters employed in many experimental setups and permanent installations are sensitive, delicate, and expensive. The danger is great that such instruments will be damaged by overload. And very often the overload comes too fast for the technician to save the meter. The prudent operator therefore will provide some means of protecting sensitive meters even if a circuit is assumed to be trustworthy.

Several meter protection schemes are shown here. All except one are fully automatic in operation. Many such circuits have been devised and every laboratory or shop probably has its favorite; but in making the selection for this article, we have tried to avoid the unnecessarily complicated arrangements, as well as the notori-

ously unreliable ones. The Editors do not feel that there is a best protection circuit; rather, each scheme is suited to a particular environment.

Multiple Meters

One of the simplest schemes is a manual one. By means of separate meters of increasing sensitivity switched into the circuit and removed therefrom successively, the operator satisfies himself that the current is not too high for the most sensitive meter which then is switched into the circuit last. Although not completely foolproof, this method has a long history of reliable performance.

Figure 1 shows the multiple meter method. This arrangement often is used in insulation testing where a delicate millimicroammeter is connected in series with an insulation sample and

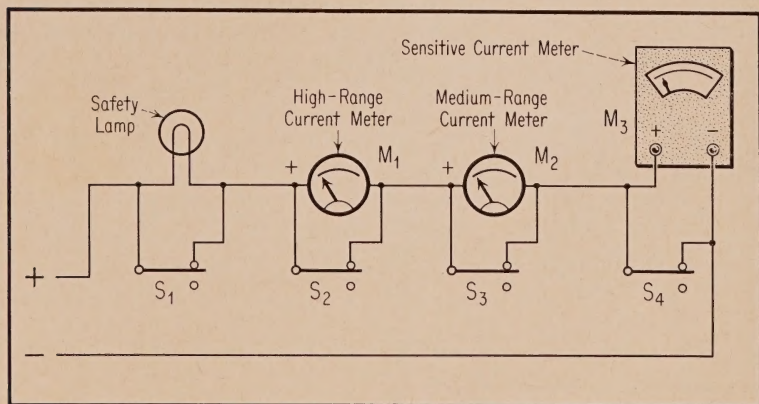


Fig. 1. Multiple Meter Method.

a high-voltage source (500 v to several kv) to measure tiny leakage currents. If no protection were used and the sample were short-circuited or very leaky, the high voltage would quickly destroy the meter. In the arrangement shown in Figure 1, all of the switches first are closed. Then the following procedure is carried out: (1) Open S_1 . This connects the safety lamp (usually a 115-volt incandescent type) into the circuit, but the closed switches keep the other meters safely out of the circuit. If the lamp glows, there is excessive current flow. (2) If the lamp does not glow, close S_1 and open S_2 . This inserts the high-range current meter M_1 only into the circuit. If the

deflection of this meter is high, both M_2 and M_3 would have been damaged had their switches been opened. (3) If the M_1 deflection is zero or low close S_2 and open S_3 . This inserts only the medium-range current meter M_2 into the circuit. If the deflection of this meter is high, M_3 would have been damaged had S_4 been opened. (4) If the M_2 deflection is zero or low, close S_3 and open S_4 . Now, only the sensitive current meter M_3 is in the circuit. At this point, take the desired reading with M_3 as quickly as possible, and close S_4 immediately after.

Some attempts have been made to substitute overload relays for the switches so as to do the job automatic-

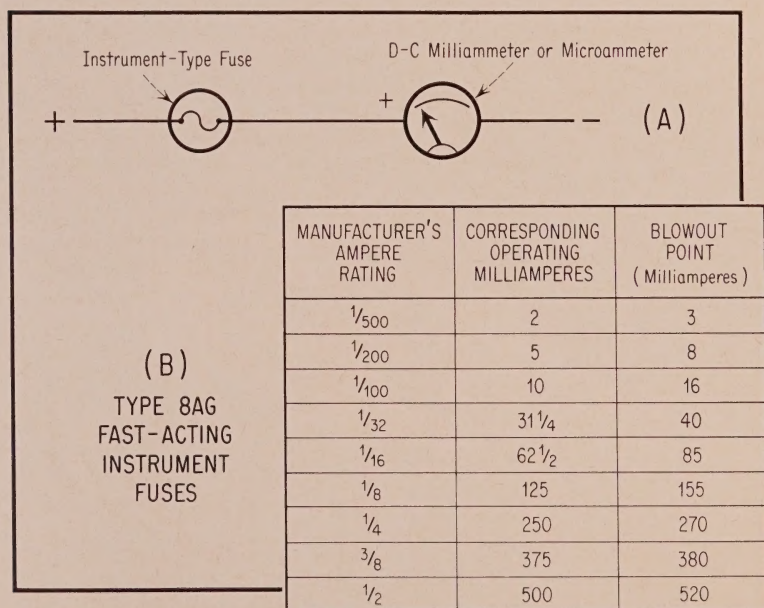


Fig. 2. Meter Fusing.

ally. However, sensitive microammeters often are damaged by pulses which occur too quickly for the appropriate relays to close and short-circuit the meter.

Meter Fusing

The simplest automatic protection device is a fuse, and its use is strongly recommended where feasible. But fuses are not available for all instrument ranges and they are not desirable in all instances (chiefly because of their resistance). A fuse is inexpensive, easily replaceable, and reasonably quick acting.

Figure 2(A) shows the simple circuit for fusing a d-c milliammeter or microammeter. For this purpose, miniature glass tubular fuses are available in the fast-acting type. The table in Figure 2(B) lists those Type 8AG instrument fuses which are useful with milliammeters of the sensitivity commonly encountered in electronic setups.

The resistance of the fuse increases as the ampere rating decreases. At the very low current ratings, the resistance is high enough that it might cause serious error if not taken into account. The meter usually must be recalibrated with the fuse in the circuit. Furthermore, the fuse resistance is nonlinear at low current levels, and this may cause square-law crowding in some part of the meter scale.

All of the fuses listed in Figure 2(B) are rated at 250 volts.

Diode Circuits

The nonlinear resistance of semiconductor diodes is a useful mechanism for meter protection. Figure 3 shows several circuits.

The forward characteristic of a high-current germanium diode (such as a gold-bonded type) may be utilized to bypass excess current around a d-c milliammeter or microammeter. In this application, the diode functions as an automatically variable shunt resistor, connected as shown in Figure 3(A) with its anode positive. The forward resistance of the diode decreases with increasing current or voltage, as shown in Figure 3(B), thus increasing the meter range automatically as the current increases.

This simple scheme has two drawbacks. First, the meter is always shunted by some value of resistance supplied by the diode. However, at the low voltage drop of the meter (approximately 100 mv for a 0-1 d-c milliammeter) the diode resistance is relatively high (2500 to 10,000 ohms, depending upon diode type and manufacture) and the shunting effect at a given current level would alter the meter calibration only slightly. Second, and more serious, however, the diode resistance varies nonlinearly. (See Figure 3B.) This means that the meter must be recalibrated with the diode in place.

When some additional circuit complexity can be tolerated, the need for a special dial calibration to offset the diode nonlinearity may be overcome with the silicon diode circuit shown in Figure 3(C). Here, the diode is biased to a d-c voltage corresponding to the normal full-scale voltage drop of the meter (say, 100 mv) by a potential developed across a very low resistance (e.g., 1 ohm) R_2 by current from a $1\frac{1}{2}$ -volt cell, B. This voltage is set exactly by means of rheostat R_1 .

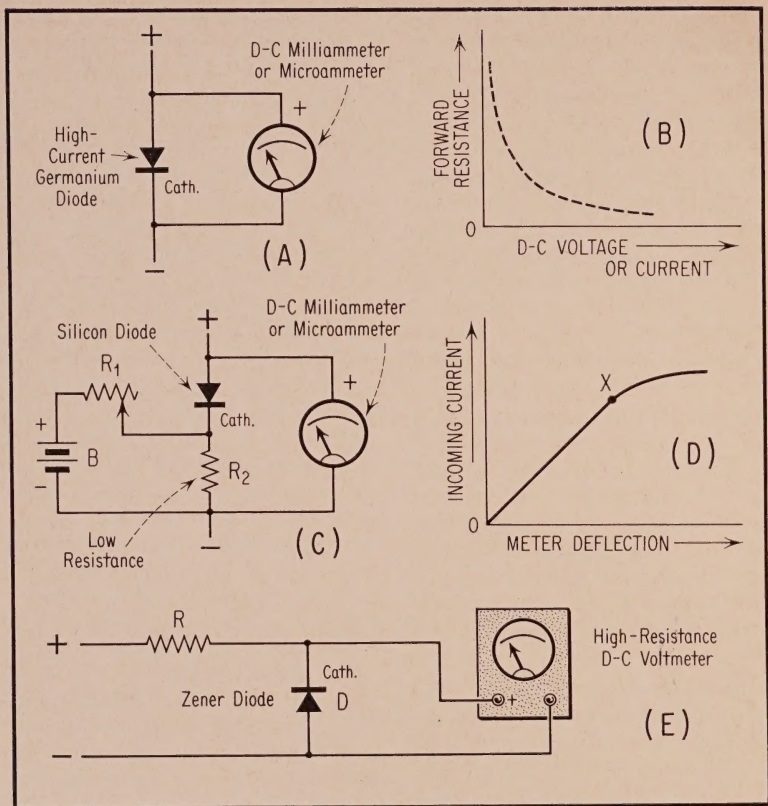


Fig. 3. Diode Protector Circuits.

The very high back resistance of the silicon diode prevents the voltage drop across R_2 from initially deflecting the meter.

As a result of the bias, no current can flow through the diode until the voltage at the anode and the positive terminal of the meter exceeds the bias. Thus, the diode is effectively switched-off until the applied voltage reaches this level. The meter deflection there-

fore increases linearly to full scale (point X in Figure 3D) and no special calibration is required. Thereafter, current flows through the diode, and the meter is shunted, preventing its deflection from increasing to an unsafe point above full scale.

The sharp reverse breakdown of a zener diode may be utilized to protect a d-c voltmeter in the circuit shown

in Figure 3(E). The current limiting resistance, R , is chosen very low with respect to the internal resistance (multiplier plus movement) of the voltmeter, and to limit the diode current to the maximum continuous zener level. The zener breakdown voltage must correspond to the full-scale deflection of the voltmeter.

In this circuit, the diode is reverse-biased by the applied voltage. Until the zener voltage is reached, the reverse resistance is very high and the voltage division resulting from R and D in series is negligible. At full-scale deflection voltage, however, the diode reaches its zener point and suddenly conducts heavily. The diode resistance consequently drops to a low value and the voltage division through R and D increases to a practically constant value. The resulting voltage regulation limits the voltmeter deflection substantially to full-scale, while the input voltage increases beyond this point.

In designing this type of protection circuit, the first task is to select a zener diode whose breakdown voltage is equal to the full-scale deflection of the meter. Zener diodes presently are available in a wide variety of stock values of voltage breakdown.

Relay Circuits

Meter protector circuits which depend upon sensitive d-c relays for their operation are recommended principally for permanent installations, such as switchboards and test panels. Such relays usually cost from two to

several times the price of inexpensive panel-type meters. But their cost is justified in most installations, since the possibility of several meter burn-outs and attendant down-time is serious.

Figure 4(A) shows the simple series-relay circuit. The relay closes just slightly above the full-scale current of the meter and short-circuits the instrument. As soon as the current falls to a safe value, the relay opens, inserting the meter again into the circuit. Here, the resistance of the relay coil must be low, to prevent excessive voltage drop; milliampere- and micro-ampere-type relays are available with coil resistances between 5 and 100 ohms.

In some instances, it is not desirable to short-circuit the meter, since the instrument then reads zero as long as the current overload continues, and there is confusion as to whether absence of deflection means zero current or excessive current. Instead of shorting the meter, the relay contacts in Figure 4(B) connect a shunt resistor R across the meter to boost its range when the current exceeds the full-scale deflection of the basic movement. Thus, a 1-ma meter may be switched to 10 ma. An extra pair of contacts on the relay can be used to switch-on a pilot light to warn the operator to read the high range of the meter.

Often, a sensitive relay available for a given full-scale meter deflection unavoidably will have a high-resistance

coil. Such a coil would introduce an objectionable voltage drop ahead of the meter in the series-type circuit. Figure 4(C) shows how a high-resistance unit might be used. Here, the current meter is connected in parallel with the relay coil, but the coil resistance is so high with respect to the internal resistance of the meter that the shunting effect is too slight to alter the calibration materially. (For example, a 5000-ohm, 1-ma relay coil in parallel with a 0-1 d-c milliammeter having an internal resistance of approximately 100 ohms would increase

the full-scale deflection only to 1.02 ma, an error of plus 2%.)

As in the earlier circuits, the relay sensitivity (pull-in current) is chosen equal to the full-scale deflection of the meter (or slightly higher). Currents higher than the full-scale value then will close the relay, connecting the shunt resistor R across the meter to boost its range. A second pair of contacts on the relay may be utilized to turn-on a pilot light signalling that the meter is switched to its higher range.

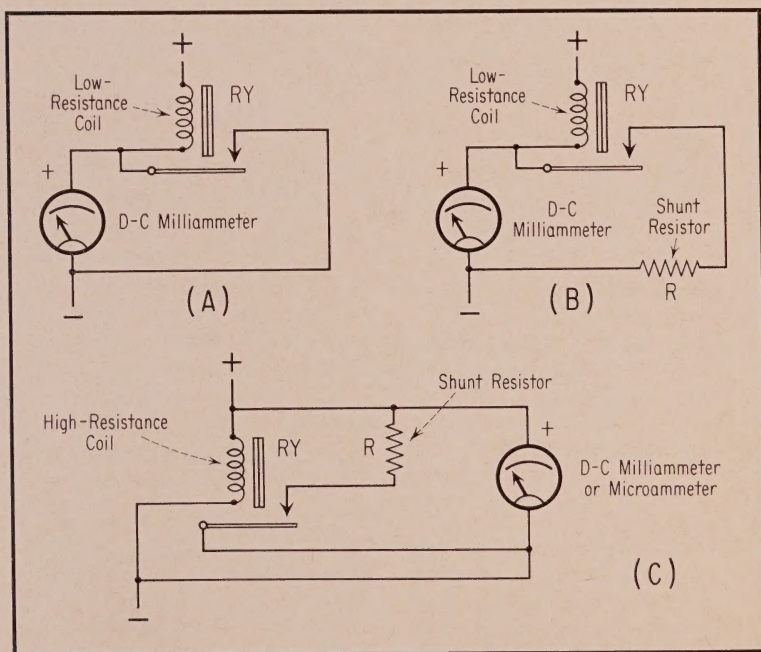


Fig. 4. Relay Protector Circuits for Current Meters.

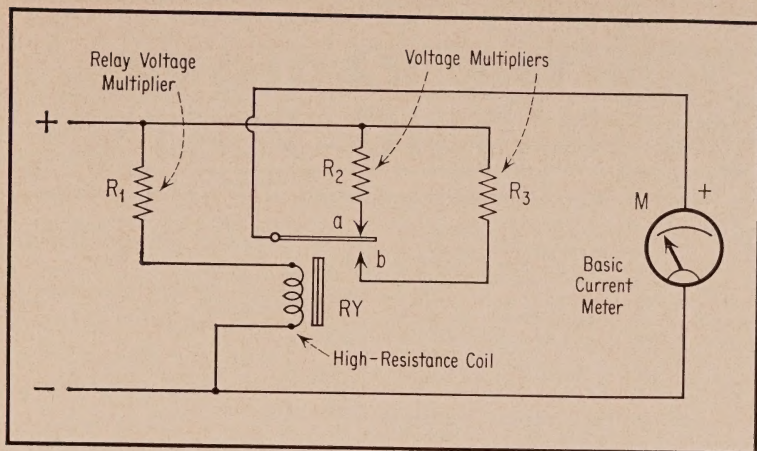


Fig. 5. Relay Protector Circuit for Voltmeter.

Figure 5 shows a relay-type protector circuit for a d-c voltmeter. (The voltmeter is composed of a basic milliammeter M and a multiplier resistor R_2 or R_3 .) The relay is chosen for low current operation, say 50 to 100 microamperes. This application calls for a high-resistance relay coil, to minimize loading of the voltage source. The relay must also have two contacts, with closure normally to the upper contact a .

When the relay is unenergized for closure, multiplier resistor R_2 is in series with the current meter, and the resulting voltmeter has its lowest range (full-scale voltage = E). The relay multiplier resistor R_1 is adjusted so that the relay closes at a voltage just slightly higher than E . When the applied voltage exceeds E , the relay closes, disconnecting R_2 and switching in a higher-resistance multiplier R_3 in

series with the meter to boost the latter's range. If available, a second armature and contact on the relay may be employed to close a local voltage through a pilot lamp to signal that the meter has been switched to its higher range. When the voltage subsequently falls to a safe value, the relay drops out, switching the meter back to its lower range.

Conclusion

The circuits shown in this article are typical but do not exhaust the possibilities by any means. Tubes or transistors may be employed in place of relays and provide nonmechanical, but somewhat more complex, circuitry. In some applications, thermistors or Thyrite resistors may be used instead of diodes. Other combinations suitable for particular applications will suggest themselves to the ingenious technician.



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SELL OR SWAP — B&K 200 pix tube ckr.-rejuvenator, \$25; audio generator AG9A assembled Heathkit, \$31; Weston 773 tube checker, \$18; Philco VTVM 7008, \$25; Heathkit 0-12 scope, 1 n., \$65. Want tape recorder. S. W. Kovacs, 8605 Emrich Ave., Fern Creek, Ky.

FOR SALE — AF-67 Elmac, 1 year old; 6 v. DC G.E. dynamotor, 640 v. output, 240 Ma.; BC-454 3-6 Mc. converter; mobile antenna with 75 meter center loading coil. All for \$190 FOB. Paul A. Dancy, 511 Avondale Court, Mobile, Ala.

FOR SALE — Garrard player model T with GE cartridge; Heath WA-P2 pre-amp with power supply; BC-1A AM tuner. All in fine cond., make offer. G. J. Reichert, 4833 Upton Avenue South, Minneapolis, Minn.

WANTED — Smart servicemen to recognize remarkable value in Cornell-Dubilier's "30-30" Promotion. Fourteen new electrolytic capacitors for \$8.67 (normally almost 2X more). At all CDE Distributors.

WANTED — Instruction manual and/or schematic for Supreme 561 sig. generator. State price. William Ungvarsky, 157 Hawthorne Ave., Yonkers 2, N. Y.

FOR SALE — Superior 82A tube tester, \$25. David Posner, 1027 Walton Ave., Bronx 52, N. Y.

SELL — HQ-129X, NC-125 with speakers, HQ-100C, BC-342N, and 348N, 28 v. DC and 120 AC, BC-455's. Make offer, all very good cond. Marshall, 455 Washington Ave., Dumont, N. J.

SERVICE — Repair all size speakers, send your speakers to us for reconing and we will mail to you the next day. Write for information. M. F. Sweeney, 922 W. 5th St., Winona, Minn.

FOR SALE — Allied Hi-Fi preamplifier kit, assembled and operates well, \$35; 25 w. amplifier, \$30. Howard Clewett, 2732 Sheridan Way, Sacramento 21, Calif.

TRADE — Coin-operated radios, excellent cond., for test equip, ham receiver, etc. W. V. Richardson, 2064 So. Parkwood, Wichita, Kan.

FOR SALE — B&K Dyna-Quick 500 tube tester; Eico 425 scope; Simpson 383 in-circuit capacitor leakage tester. John Swiech, 114 Roosevelt Dr., Utica, N. Y.

FOR SALE — New electrolytic capacitors that are 30% smaller, 30% more reliable, 30% below regular cost. See your Cornell-Dubilier Distributor. Ask for the "30-30" Deal.

FOR SALE — Philco G-8000 VHF to UHF sig. generator adaptor, \$75 COD. F. A. Rand, Box 207, Winthrop, Maine.

SELL OR SWAP — 125 w. Hallicrafter table top PH/CW bandswitch transmitter, 10-75 meters, complete. Want 4" to 6" reflector telescope, good late model outboard motor, or \$150 cash. R. A. Bost, Missouri State Highway Patrol, Popular Bluff, Mo.

WANTED — Any information or manual with schematic on Federal UHF signal generator 804-CS2, covering range from 8-330 Mc. Quote price. M. Labuda, 8934 East Beatrice Pl., Rosemead, Calif.

WANTED — Riders Perpetual Troubleshooter's Guide, Vols. 9 and 13, and about 50 Sams Photofact Folders, between 1 and 400. Peter Shulin, 645 Hayes Ave., Washington, Pa.

WANTED — RME MC-53 VHF 3-band mobile converter. Louis Mihalyty, 7929 Rosedale, Allen Park, Mich.

FOR SALE — Philmore CR-5AC comm. receiver in fine cond., with cabinet and manual, \$50. Ronald Munzert, 73 Oakdale Ave., New Hartford, N. Y.

TRADE OR SELL — 20 ft. inboard skiff, with 75 hp Gray Marine engine, for communications receiver, Hi-Fi, or what have you? J. Lewis, 2835 Willard Ave., Oceanside, L. I., N. Y.

FOR SALE — Regency RC-600; Electro-Voice 3900 UHF converters, \$10 each; Johnson Matchbox, \$30; pair 4-125A's, \$25. M. H. Klapp, 17 Kenosha St., Albany 9, N. Y.

WANTED — Job in warm dry climate. Have twenty years' experience in radiol Anthony Bruno, 6812 11th Ave., Brooklyn 19, N. Y.

FOR SALE — Stancor 752 battery eliminator 6-12 v., 12-25 amps., \$30 plus freight or best reasonable offer. Robert W. Gosseine, 9406 Seminole Street, Silver Spring, Md.

WANTED — BC-779 or BC-794 radio comm. receiver in good working condition. D. Landesberg, YMCA, 179 Marcy Avenue, Brooklyn 11, N. Y.

SELL OR SWAP — 1921 battery operated, 3-tube receiver, restored to new cond.; also Radio City VTVM, needs work. Best offer. R. F. Hill, 386 Roosevelt Ave., Lyndhurst, N. J.

FOR SALE — HT9 transmitter with all coils in very good condition; NC-100 receiver in good health. Bernard Annenberg, Thomas Jefferson H. S., Brooklyn 7, N. Y.

WANTED — Meter for Vomax 900 VTVM. State condition and price. R. E. Chamberlain, 790 Wyoming Dr., Santa Rosa, Calif.

SWAP — Complete rubber stamp-making outfit, less than year old, with accessories, instructions, for Hi-Fi or ham 6 meter equip, fixed or mobile. Stanley Cranker, 31 Warren St., Warrensburg, N. Y.

SELL OR TRADE — Hickok 191X sig. gen., dual crystal controlled with built-in VTVM and manual, \$65; Telematic TVI analyzer with the manual, \$10; Espey model 104 tube tester and VOM combination, no manual, \$25, or trade for TS-34AP, Waterman S-10-A. Robert Wendel, 160-20 Grand Cent. Pkwy., Jamaica 32, N. Y.

WANTED — Coils for McMurdo-Silver 903 freq. meter, Type 101-102-103 inductors, instruction manual. Cash or trade reflector telescope 2" objective, tripod; Eico VTVM, photo gear, for Heath 3" scope, grid dis meter. Theodore Nadeje, 5101-AA 39th Ave., Sunnyside 4, N. Y.

FOR SALE — Like new Heath WA-P2 pre-amp and W-5M Hi-Fi amplifier, sell together or separate, for cost of kit alone. You save work of wiring. R. Jos. Flowers, 33 No. 18th St., Harrisburg, Pa.

SWAP — Metal tube caddy, tenna rotor, TV boosters, tube brighteners, phono motors, voltmeter, rectifiers, meters, relays, speakers, for what have you? Thomas Rohland, R. 3, Martinsville, Ind.

TRADE — Fourteen new CDE electrolytic capacitors for \$8.67. At all Cornell-Dubilier Distributors. Ask for the "30-30" Promotion.

SWAP — RCA TV calibrator 39B and TV sweep gen. 59B; Hickok 650 Vidol gen. converted for color, Eico 425 scope for good "ham" gear, tubes, rcvr., etc. Claude C. Yeager, 2350 So. Washington, Wichita 11, Kan.

FOR SALE — Gonset Tri-band 6 v. with noise silencer, used 3 hrs. Irving Kopolow, 715 W. 172nd St., New York 32, N. Y.

FOR SALE — Harvey Labs. sweep gen., \$18; Electro-Voice TV distribution amp., 4 outlets, \$8; UHF butterfly tank condenser, \$1.50; Standard coil VHF TV tuner, \$5; UHF-VHF TV tuner, \$6; time delay relay, 5 sec. to 1 min., \$2. John Christy, 14553 Dickens St., Sherman Oaks, Calif.

FOR SALE — Precise 909 VTVM, Eico 221 VTVM, Superior TD55 tube ckr., Heath BG1 bar. gen., \$15 each; Presto 6D table with 1C cutting head and Presto EU7 recording amp., \$700 value for \$175. J. Eastwood, 868 Center Dr., Franklin Sq., L. I., N. Y.

SELL — Viking II, \$150; 2 meter communicator, \$215; field strength meter, \$15. Want KWM $\frac{1}{2}$, speaker/control box for use with KWS-1/75A4, D104, bug. K. M. Miller, 14979 La Cumbre Dr., Pacific Palisades, Calif.

SELL OR TRADE — 2 JRC 400 Vocaline 465 Mc. citizen transceivers with mobile antennas; 6-12-110 v., 1955 Ford radio, Philco 2" pocket scope. C. Leo Clark, 273 Fairgreen, Youngstown 4, Ohio.

FOR SALE — Terrado DC-AC power converter, Chief 6 v., 75-100 watts, good cond., used very little, \$25 COD plus postage. Al Reiners, Box 395, Hyannis, Mass.

FOR SALE — Globe transmitter 680-A with 6-meter power booster; Hallicrafters receiver SX-71. Make offer, both in good shape. John Arnold, Wilson St., Bluffs 3, Ill.

WANTED — NC-125 in good cond.; Eico 950 RC bridge and 147 sig. tracer, for cash or part cash and trade tube tester, and misc. T. Ferguson, 171 E. 91st St., New York 28, N. Y.

WANTED — Heathkit XO-1 electronic crossover, \$10. Will pay FOB charges. R. N. Brunt, 61 So. Spring St., Elizabeth 4, N. J.

TRADE — RCA 21CT7895 color TV in A-1 shape, pix tube included; 12,000 v. Neon xformer. Need ham gear. Don Thomas, Box 367, Silverton, Tex.

FOR SALE — In-circuit capacity checker, wired and ready for use, plus instruction booklet. Price \$8 M.O. Joe McRuiz, 4975 So. Cinn Ave., Tulsa 5, Okla.

SERVICE — Send kit (not tampered with) and 15% of cost or cost plus 20% and I will order. Assembled units rushed express collect. Stout TV, 10131 East 40 Hwy., Independence, Mo.

FOR SALE — Heath WA-P2 Hi-Fi pre-amplifier, in good cond., \$14; Knight Hi-Fi FM tuner, recent model, \$35; and BC-458 40 meter VFO, completely converted, \$10, both like new. Victor Wong, 430 Southview Ave., Cincinnati 19, Ohio.

FOR SALE — Year old Fisher M-scope Explorer, metal locator in good cond., was \$158.50, sell for \$110. Hamilton Pollard, R. 1, Box 424, Marysville, Calif.

FOR SALE — NRI communications course, with all lessons and assembled xmitter, \$70. Olsen Radio, West Main St., Kingsville, Ohio.

WANTED — Instructions and maintenance manual incl. schematic for Washington Institute of Technology RF sig. gen., model 43-41, 5 to 175 Mcs, any cond. if readable. Harold G. Sedgwick, 708 Upson, El Paso, Texas.

WANTED — Boonton Q-meter, 160A or 260A, state serial number, cond., and price. A. R. Blanck, Box 162, Rutherford, N. J.

FOR SALE — Like new Collaro RC440 4-speed record changer, with Pickering 3710 diamond needle stereo cartridge, \$30 plus shipping. Leo Stolove, 505 Rockaway Pkwy., Brooklyn 12, N. Y.

FOR SALE — TDZ xmitters, \$25 up; Associated RDZ receivers 200-400 Mc, \$20, with tubes and crystal oven; surplus gear and components. Bill Watson, 96-01 133 Ave., Ozone Park 17, N. Y.

FOR SALE — Hewlett-Packard 200 BR audio oscillator; vacuum tubes: 6X4, 6X5, 6X6, 6X7, 6X8, 6X9, 6X10, 6X11, 6X12, 6X13, 6X14, 6X15, 6X16, 6X17, 6X18, 6X19, 6X20, 6X21, 6X22, 6X23, 6X24, 6X25, 6X26, 6X27, 6X28, 6X29, 6X30, 6X31, 6X32, 6X33, 6X34, 6X35, 6X36, 6X37, 6X38, 6X39, 6X40, 6X41, 6X42, 6X43, 6X44, 6X45, 6X46, 6X47, 6X48, 6X49, 6X50, 6X51, 6X52, 6X53, 6X54, 6X55, 6X56, 6X57, 6X58, 6X59, 6X60, 6X61, 6X62, 6X63, 6X64, 6X65, 6X66, 6X67, 6X68, 6X69, 6X70, 6X71, 6X72, 6X73, 6X74, 6X75, 6X76, 6X77, 6X78, 6X79, 6X80, 6X81, 6X82, 6X83, 6X84, 6X85, 6X86, 6X87, 6X88, 6X89, 6X90, 6X91, 6X92, 6X93, 6X94, 6X95, 6X96, 6X97, 6X98, 6X99, 6X100. C. A. McKay, 106 W. 14th St., 21st Floor, Kansas City, Mo.

WANTED — Collins surplus CFI unit containing 50 Kc & 150 Kc IF transformers. Don McLaughlin, 3730 Camden St. SE, Washington 20, D. C.

FOR SALE — 80, 40, 20, 10 BVL coils with swinging link jack bar assembly, \$10; Astatic T-3 mike with Type "G" press-to-talk stand, \$18; 2" Weston RF Thermo-Ammeter 0-3, \$5. A. R. Bentley, 8 No. Beach St., Nantucket, Mass.

WANTED — Ham gear: 2-meter and 6-meter low-noise converters or receivers, transmitters, reasonably priced. R. F. Van Winkle, 643 Aurora Ave., Santa Barbara, Calif.

FOR SALE — Concert speakers 12" in carrying case; rotary converter 32 v. DC to 110 v. AC; 16 mm sound films. Send for list. William H. Lorimer, 432 Sheridan St., Williamsport, Pa.

FOR SALE — Like new radio and TV test equipment, includes 5" Heath scope; Sams, and Riders Vol. 18. All for \$235. Daniel Seidler, 2644 W. 23rd St., Chicago 8, Ill.

FOR SALE — High-voltage 100 to 1 divider probes, used with scope, full instructions, calibrated — a must for tough high-voltage problems in TV repair, \$12.50 each COD. Johns Radio, 1619 Ferry St., Easton, Pa.

FOR SALE — Precision E-200-C sig. gen. with 2 xtals; Precision E-400 sweep gen. Best offer. Crose TV, 102 No. Clifton, Park Ridge, Ill.

FOR SALE — Hi-Fi equip., 6 mos. old: Bogen DB130 35 w. amplifier, \$75; University speaker cabinet (ebony finish, complete crossover, 15" woofer C-63W, tweeter T-50 with H600 horn), \$125. E. Brezzy, 57-42 163 St., Flushing 65, N. Y.

FOR SALE — 810's, 813's, \$7 each; 814's, \$2 each; 304TL, 304TH, \$5 each; pair 110 v. AC selsyns, \$8.50; Butterfly B&W cond., CX40A 1/2" spac. with neut. cond., \$12. E. A. Jefferson, 107 Thompson St., Allegan, Mich.

FOR SALE — Set code practice records and amateur radio course, \$10; Heath QF-1 Q multiplier, \$10; NRI radio-TV servicing course, \$15, all postpaid. W. L. Jesson, 25 Pine St., Geneva, N. Y.

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WANT — Used Radio-TV correspondence course, with or without kits, must be recent, complete, in good cond. State price. Mack Iworsley, 24 South Bowdoin St., Lawrence, Mass.

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TRADE — Five Target Hunter ball gum vending machines, value \$400. Can use ham receivers, xmitters, testers, anything in the electronic field. Glenn C. Garvin, Smith's Ferry, Pa.

FOR SALE — 47-lesson ICS Radio and TV Servicing course, best offer. Clifford A. Miller, Dodge Center, Minn.

WANTED — Magnet charger, Radio Frequency Labs. make, Model 107 or 107A. A-1 condition required. Lynn Instrument Repair, 2108 Essex St., Berkeley 5, Calif.

FOR SALE — Hammarlund HQ-150 with speaker, in very good cond., \$147. J. Clemente, 71 View St., Bergenfield, N. J.

FOR SALE — Ekotape 116 tape recorder, \$40; portable G.E. radio 250 needs battery, \$18; Electro-Voice 725 mike, \$20; Philco tuners for model 1000, \$7 each. Al Crispo, 85-02 133rd Ave., Ozone Park 17, N. Y.

FOR SALE — Heath TS-4A TV align. gen., \$30; Century TT-2 transistor tester, \$15. Both like new. Bob Nelson, Box 425, Dassel, Minn.

FOR SALE — Leeds Northrup Wheatstone Bridge Type S, \$75; Radio Electronics and TV News magazines Jan. 1933 to present, make offer. Also TVs, amplifiers, parts. M. Socha, 492 Von Elm Ave., East Meadow, L. I., N. Y.

FOR SALE — QST, Feb. 49-59; Radio-TV News, 53-59; G-R Experimenter, 50-53; C-D Capacitor 49-59; Riders Successful Servicing, 50-54; H-P News, 51-55; CEC Recordings, 49-54; Amphenol Eng. News, 54-59; Audio Record, 51-56; others. No single copies. R. H. Ives, Rt. 2, Box 32, Lynnhaven, Va.

FOR SALE — Knight kit model T50, 50 w. xmitter, excellent cond., \$30. Delivery within 50 miles of N.Y.C. Mark Drapkin, 203 Van Nostrand Ave., Jersey City 5, N. J.

WANTED — Measurements Corporation used sig. gen., model 80, 65B, and 71 square wave generator. Equal models considered. L. J. Schnedorf, 610 Monroe Ave., River Forest, Ill.

TRADE — Geiger counters for Sams Photo-facts. Electronic Service Lab., 2405 2nd Avenue North, Billings, Mont.

WANTED — Instruction book for model 198 Hickok audio oscillator. Will send 1000 mixed resistors for use or will buy. Allan Kaspar, Box 441, Munford, Tenn.

WANTED — Instructograph, AC 110 v., 60 cy. motor, with oscillator, tube, and tapes. James A. Cox, 903 W. Arch St., Portland, Ind.

WANTED — National FB7, FB7A, FBX, FBXA receivers. Need not be in working order. Also SW-3. J. D. Grigas, 258 Coe Rd., Clarendon Hills, Ill.

WANTED — 500 to 1000 watt, all band transmitter CW-AM or linear at reasonable cash price. Need 10-15-20 meter, full size beam and rotator. A. Haberman, 129 Morgan St., Holyoke, Mass.

TRADE — Lettine short wave gear for test equipment. Local only. James Hill, 110-26 175th St., Jamaica 33, N. Y.

WANTED — Hickok test equip., scope 675A, 685, or 770, sweep and marker generator 615 and 900C wattmeter. Joe Salkawske, Maple Park, Ill.

SELL OR TRADE — 120 w. CW, phone, VFO xmitter, NC-101-X receiver — complete station 80-10 meters. Want test equip., electronic organ, typewriters, or? H. Cohan, 1935 83rd St., Brooklyn 14, N. Y.

FOR SALE — DX-100 transmitter, very good cond., professionally wired, factory recommended modifications only including continuous Pi network. Worked all states and 36 countries, \$150. R. W. Spradling, 651 Saratoga Dr., Chicago Heights, Ill.

SELL OR SWAP — SX71 receiver in good condition, \$150, or trade for tape recorder. R. G. Gould, 281 So. Castanya Way, Menlo Park, Calif.

FOR SALE — Heathkit BE-4 battery eliminator, 6 and 12 volts, very good cond., \$25. C. Elgasser, 1920 Fern St., San Diego 2, Calif.

WANTED — 1927 and earlier copies of Radio News and Radio Broadcast magazines; also early battery operated radios, tubes, parts, and speakers. Have good trades for same. Paul Thompson, 1300 So. Main, Las Vegas, Nev.

WANTED — Gonset 10-11 meter converter; Stancor or other 10 meter mobile transmitter; good noise clipper and 10 meter ground plane antenna. W. Kryger, 4918 Beech St., Hammond, Ind.

SWAP — Heath TV alignment generator and scope, both very good cond., for good comm. receiver for 10-20-40-80-160 and 6 meters. Need Reflex speakers with drivers any size. David Oehlson, 3507 Rossville Blvd., Chattanooga, Tenn.

WANTED — Schematic diagram of power supply for 24-volt surplus gear — was in July 1948 QST. Duncan Brown, Earlville Road, Hamilton, N. Y.

SELL OR TRADE — Supersonic 107 TV-FM amplifier 7 1/2" wide x 5 5/8" high x 4 3/8" deep, 117 v. AC, 15 watts; TV Permanent Magnet Focalizer 8739-270005. Both working good as new. Alexander Podstepny, 1652 Dounton St., Philadelphia 40, Pa.

WANTED — 1953 Chevrolet radio, push-button model. Cash and/or Weston 697 VOM. State price and condition. George R. Easton, 2007 Eagle St., Baltimore 23, Md.

WANTED — Volume I RCA Pict-O-Guide in good cond., also other books and test equip. Send price. Chas. Crank, 910 West Colonial Dr., Orlando, Fla.

FOR SALE — Clough-Brengle Co. 79C No. 1530 precision audio generator, resp. 20-15 Kc., in perfect shape and operation. Will take first good offer. A. H. Hawkes, 10 Hardy Rd., Westbrook, Me.

WANTED — 4 x 5 Graphlex or Speed-graphic. Trade Hallicrafters Echophone comm. rcvr.; Practical Radio Communication by Nilson, Horning. G. Lynch, 70 Woodfin Ave., Asheville, N. C.

FOR SALE — Supreme 589 tube tester, in fine condition, with manual and schematic, \$30. Jack's TV Service, 296 Wainwright St., Newark 12, N. J.

WANTED — Projector for 35 mm slides. Give brand name, description, cond., and price. Kirk M. Lumsden, 1103 Arney St., Elizabethton, Tenn.

TRADE — Surplus parts and equipment for what have you. Tell me your needs. Joaquin A. Araujo, Box 2011, James Cannally A.F.B., Texas.

WANTED — Copper wire either Formvar or enameled covered 28, 29, and 30 size. Will consider any amount. Stanley J. Zuchora, 2748 Meade St., Detroit 12, Mich.

SWAP — HO model trains: 5 engines, fifty cars, hundreds of feet of track, fifteen switches, etc. Want public address equip. H. Piller, 451 Thieriot Ave., Bronx 72, N. Y.

WANTED — University speaker, 8" Diffusicon or similar. Charles K. Gabler, 1307 Merriam Ave., New York 52, N. Y.

SELL — Superior new-model TW-11 standard professional tube tester, practically new, \$35 FOB. E. Magnano, Rt. 1, Box 100, Durham, Conn.

SELL — 20 meter TVL coil, full size 20 meter beam, single 813 transmitter, 50 w. exciter or transmitter, 1800 v. DC power supply, 3000 v. DC 4 mfd. capacitors, T-17 mike, various meters, xmitting condensers, chokes. Make offer or write for list. W. E. Jones, Box 4, Bowmansville, N. Y.

FOR SALE — Altec Lansing 604-C, PT-1 Heath pro. AM-FM tuner, A-1 alignment and in top cond., 75 w. Ultra-Linear amp. in like new cond. G. E. Howarth, 216 1st Ave. E., Oskaloosa, Iowa.

FOR SALE — Tel-Ohm-Mike TO-3 capacitor tester with instruction manual in very good cond., less than half price. Joe Barsomian, 21 Porter St., Watertown, Mass.

FOR SALE — Precision multimeter, 20,000 ohms per volt in carrying case, \$40. J. Laflie, 6146 So. Kenneth Ave., Chicago 29, Ill.

BARGAIN — Collins 32V-3 transmitter, with complete extra set spare tubes, plus Collins Low Pass RF filter, \$350 (no trades). J. Knight, Mount Wilson, Calif.

FOR SALE — Harvey-Wells 50D phone & CW xmitter with AC power supply, good cond., \$70 cash or money order postpaid. E. Comeau, 431/2 6th Ave., Haverhill, Mass.

FOR SALE — Centralab TA-11 4-stage transistor amplifier, complete except for external vol. control Centralab B16-117 or 16-217 with switch, \$25. Bob Eubank, 1227 Windsor Ave., Richmond 27, Va.

WANT — 6 meter convertor, 150 Mc police rcvr., 829B, 815 tubes, disc recorder. Have 16X binoculars, 35 mm. cameras, TV boosters. M. McDonald, 25 Crescent Street, Lawrence, Mass.

WANTED — Ham receiver, AC only. State make, model, features, condition, and lowest cash price. R. Mehrl, 719 Ries St., Dubuque, Iowa.

WANTED — Instruction manual for EV-10 Precision VTVM. Sprock's Radio & TV Service, Box 90, Rector, Pa.

SELL OR TRADE — Unused BC611 walkie talkie, with instruction book. A. L. Friel, 9 Jill Lane, Trenton 8, N. J.

WANTED — Small scope 5" or less, both cheap and operative, also test equip. at low prices. B. T. Brinson, 1110 North Miller, Oklahoma City, Okla.

FOR SALE — Riders Radio manuals 1 to 22, good condition, \$88. Earl Sloan, Lakeview, Ohio.

FOR SALE — Collins 32RA8 xmitter; Johnson factory VFO; Millen all-band exciter; Sonar SRT-120; KW phone, CW xmitter all-band KW 40-meter CW xmitter. M. A. Sklar, 690 Willow Rd., West Hempstead, L. I., N. Y.

WANTED — Frequency and deviation measuring instruments — Lampkin — DuMont — Motorola. Trade 500 Ma. 1500 v. power supply, color TV, cash, or what have you? C. D. Justis, Newport, Del.

WANTED — 15" or 21" used color TV set chassis and cabinet. Will trade slightly used RCA 7JP4, DuMont tuner and 7EP4; complete DeVry Technical Institute course in electronics. R. Gambetta, 399 Ringwood Ave., Midvale, N. J.

SELL OR TRADE — QST: year 1938, Jan. thru July 1947, 1951 thru 1957; CQ: 1946 thru 1957. Make offer, all or part, or trade for ham gear. Reid H. Burrows, 1320 S. Apple Tree Lane, Brookfield, Wis.

FOR SALE — HQ-129-X, very good cond., complete with QF-1 Q Multiplier and integral 100 Kc. calibrator, \$130, delivery within 50 miles. Hal Scott, 134 Elliot Place, New York 52, N. Y.

SELL OR TRADE — Eimac 4-125A tubes, MW Orbital scanner, Kodak magazine 8 movie camera and model 894 projector with cases, 2 1/4" x 3 1/4" Graphic, CRF, f4.5 Tessar, Compur rapid shutter, etc. H. Burton, 1410 Glenwood Dr., S.E., Huntsville, Ala.

TRADE — Resistance-capacitance-comparator bridge, Eico 950BK, good cond., for good 5" scope, kit or wired. Clifton Johnson, 3705 Swift St., San Diego 7, Calif.

WANTED — Original tuner for DuMont RA-117-A. Must be in good operating cond. State price. Bill Mackin, 622 Wendy Lane, Elyria, Ohio.

FOR SALE — RCA WV97A senior volt-ohmmyst, complete with WG289 hv probe, crystal diode probes, leads, and manual, good cond., \$40. Tompkins Sq. Radio Co., 117 East 7th St., New York 9, N. Y.

FOR SALE — Heath Q multiplier; 6-meter crystal convertor, completely wired and perfect operating condition. \$20 takes both, or \$10 each. E. R. Giese, 302-17th St. South, Brigantine, N. J.

SELL OR TRADE — Crosley 307 10" TV set, operating, \$20; Riders 1-13, \$40. Want FM-AM or FM tuner, VTVM, capacitor tester. C. F. McCracken, 255 Foulkrod Blvd., King of Prussia, Pa.

FOR SALE — Riders Radio manuals 1-15 and TV 1-11, \$100; Kay megasweep \$110; RCA 39A TV crystal calibrator, \$40; Alliance rotator motors \$5 each; tuner strips for channels 22, 18, 30, 36 and 67R, \$1 each. V. Iavarone, 1218 Leland Ave., Bronx 72, N. Y.

SELL OR TRADE — SX-28; Eico 720 transmitter; Heath VFO, home brew mod. Want good quality microscope equip.; Altec 620B speaker in Altec enclosure; good AR-1 speaker. L. Diamond, 749 West End Ave., New York 25, N. Y.

FOR SALE — Supreme 504A tube and multitester \$25; QST's in binders 1946-7-8-9 complete, name your price; Realistic Electrostat 3 tweeter, in orig. packing \$20 with crossover network. Kudian, 607 W. 191st St., New York 40, N. Y.

WANTED — Printing presses, type, type cabinets, paper cutters. Trade Heathkit sweep generator, Simpson 260 meter, Photofacts, Riders Vols. 1 & 2, Ohmite resistor cabinets. C. E. Steelman, 1040 So. Worth St., Indianapolis 41, Ind.

FOR SALE — Precision 912 tube tester in very good cond., with manual, \$40. H. DeMarino, 2900 Barnes Ave., Bronx 67, N. Y.

BARGAINS — Ham & photography equipment. Send stamp for list. Joe Coffield, 1731 W. 1st St., Brooklyn 23, N. Y.

FOR SALE — Lab. type and broadcast equipment: monitors, amps., TV terminal equipment. D. R. Kantor, c/o Electro-Find Co., 550 Fifth Ave., New York 36, N. Y.

FOR SALE — Simpson 260, \$20; General Radio wavemeter 50-400 Mc., \$7; 3 amp. variable transformer, \$6; complete CVM2 modulator, no power supply working, \$30. Wallace Bartoshevich, 456 Grove St., So. Braintree 85, Mass.

FOR SALE — Karlson enclosure for 15" speaker, mah. formica finish, \$20; Rek-O-Kut B-12 turntable base, \$5; Fisher 80-C mah. cases \$3 each; Scott 135 walnut case, \$2; LP records. Jack Atkins, 1375 27th St., Ogden, Utah.

SELL — Crosley AM-FM tuner, 10 years old; VM 3-speed changer; small amplifier, 12" speaker, in cabinet or without. New York only. Arnold I. Bernstein, 125 West 228th St., New York 63, N. Y.

WANT — Public address systems, amplifiers, speakers, trumpets, record players, records, inverters. Will pay cash. Herbert Piller, Action Advertising, 150 Broadway, New York 38, N. Y.

WANTED — Paco sig. gen. G-30 and sig. tracer Z-80; Heathkit sig. tracer T4 and FM-4 tuner. O. Zetlmeier, 1123 Woodycrest Ave., New York 52, N. Y.

FOR SALE — Heathkit 0-10 scope, used very little, \$70, and AR-3 with cabinet, \$25; Eico 315 factory wired signal generator, little used, \$45. Raymond Carl, 1111 Vance Ave., Coraopolis, Pa.

FOR SALE — Recent Radio and TV course less kits, \$25; old radios and parts. Ted Solarz, 3033 So. Pulaski Rd., Chicago 23, Ill.

WANT — RME69 receiver; Pilot FM tuner (old FM band); BC-455. Sell or trade — Riders Radio manuals, BC-625 transmitters, 805, 832, 872A, and 24G tubes, BC-183B receiver. E. L. Felder, Tyler-town, Miss.

FOR SALE — Heathkit VTVM V-4A; Eico model 566 1000-opv; battery eliminator, 67½ volt, \$15 for all. Dewey Altizer, R. 1, Centerburg, Ohio.

SELL OR TRADE — BC-221 with AC, \$60; parts for QST 1 Kw xmtr., \$90; Bandmaster TBS-50D \$40; HRO-7 rec., spkr., 5 coils, \$175; BC-191 xmtr, \$25. Davis, 19227 Lemay St., Reseda, Calif.

SELL OR TRADE — Hickok 600A tube checker, like new, or will trade for Hickok automatic tube checker, \$125 with CRT adapter. Jack P. Jowe, 663 Peralta Ave., San Francisco 10, Calif.

WANTED — Riders manuals 15 on up, square wave gen. and field strength meter. State price and condition. Jay O'Connor, Valleyford, Wash.

FOR SALE — 4-PDT telephone type switch, 88c; 4" speaker in baffle \$2.85; ARC-5's, meters, etc. Postage extra. Send for big list. Theodore Wade, Bennet, Neb.

WANTED — Old radio receivers built before 1924. Esmond K. Volz, Elm Trailer Court, 2882 Elm Ave., Long Beach, Calif.

WANTED — Sams Photofacts and AM test generator. Sell Hickok 680 marker with crystals, cheap. Jack's Shop, R. 1, Lewisburg, Pa.

FOR SALE — B&K 350 picture tube checker and reactivator with RCA and SYL socket adaptors, \$25; Heathkit LP-1 linearity pattern generator, \$17.50; Oak Ridge 104 syncro sweep gen., \$17.50. All in very good cond. C. Soest, 12092 Kilbourn, Detroit 13, Mich.

SELLING OUT — Receivers, manuals, parts, etc. List of bargains for a stamp. M. Marshall, 455 Washington Ave., Dumont N. J.

URGENTLY NEEDED — Pair Citizen band transceivers, accessories, and pair Marine band transceivers. Cash, waiting. S. Krzak, 65 Main St., Pawtucket, R. I.

FOR SALE — Heathkit Seneca wired \$200; BC-604 xmtr in orig. crate, \$10; four each 304T1 tubes, Eimac, \$15 each; Mosley 10-20 beam \$60. Need DM-35 dynamotor. Malcolm Stone, Box 202, Fulton, Miss.

TRADE — HO train set valued at \$80 in like new condition, for SX-71 in fair cond., or any other good receiver. Bruce Simmons, 30 Balsam Crescent, New Hartford, N. Y.

SELL — Coaxial antenna relays, 115 v. AC with SPDT and DPDT aux. switches, \$10 each. Peter Bachard, 485 Sumner St., Stoughton, Mass.

FOR SALE — Harvey Labs. 205TS sweep generator, \$18; model 26 teletype and table, \$65; 700 w. 110 v. AC and 12 v. DC gas generator, \$130; Hickok 532 mutual conductance tube tester, \$50. John Christy, 14553 Dickens St., Sherman Oaks, Calif.

TRADE OR SELL — National Radio Institute's scope, sweep 15-30 and 2K-4K cycles, with or without CRT and other tubes, good working cond. Walter J. Williams, Box 92, St. Clair, Mich.

FOR SALE — Contents of Aircraft Radio Service Shop. H. F. Beane, Custom Communications, 172 Park Ave., Madison, N. J.

FOR SALE — Heath: 0-9 scope, \$35; TS-2 SW gen., \$20; SG-8 sig. gen., \$15; CT-1 tester, \$5; BG-1 bar gen., \$5; Mallory TV-101 conv., \$15. Mark R. Sorg, 140 W. Cresse Ave., Wildwood, N. J.

WANTED — Service-Operator manual for Hickok 19X signal generator. Guy C. Long, 922 Baldwin St., Elkhart, Ind.

WANTED — Name your price for QST 1915 and full year 1916, also CQ magazine for Jan. and May 1945. Urgently need C-D Capacitor 1937, 1938, and 1939, also General Radio Experimenter 1926-1931 inclusive. Jones, 713 Front St., Catsauqua, Pa.

FOR SALE — Receivers: BC-342N with voltage regulated supply, \$55; Hammarlund Comet Pro. all bands, \$35; Coast Guard 1.5 to 9 Mc, \$20. All in new cond. Have antique items. Operating and Code instruction given. P. Borri, Box 14, Hamilton, Mich.

NEED — FM receiver or tuner also SW receiver. Have Simpson 260, Year Book Wireless Telegraphy and Telephony, 1917 Edition, misc 2" and 3" meters, 500 mint U.S. plate blocks. H. Gursh, 148-37 90th Ave., Jamaica 35, N. Y.

FOR SALE — 68" encl. rack \$15; 30 w. amplifier 2 mike inputs auto record player top \$30; PP6V6 ampl. in case with 78 rpm arm and spkr. \$15; GI 78 rpm recording unit in case, \$20. Local only. Gus Jacobson, 162-04 No. Hempstead Turnpike, Flushing 65, N. Y.

WANTED — Complete NRI communication course, less kits. Norris C. McKamey, 1220 W. 7th St., Davenport, Iowa.

FOR SALE — AMECO AC-1T transmitter, xtal controlled, 2 tubes, practically new, best offer. Alfred J. Fantini, 493 East 162nd St., Bronx 51, N. Y.

FOR SALE — Globe Scout, 680, like new, \$90; BC-375 reworked 160-80-75-40 mtrs. keys good, push-to-talk, 200 w., complete, \$75; C-D BF-80 flyback transformer and yoke checker, \$30. Lincoln Chase, Knoxville, Pa.

SWAP — Unused University 12" two-way Diffaxial Hi-Fi speaker for transmitter easily converted for 160 meter phone, or make cash offer. Robert Cobaugh, 29-29 213th St., Bayside, N. Y.

WANTED — Instructograph, or any type code teaching apparatus. A. Benson, Box 420, Providence 1, R. I.

WANTED — Transmitter and receiver for radio controlled boat, preferably dual channel or tone control. Send information and price. Hal Block, 3504 Rochambeau Ave., Bronx 67, N. Y.

SELL OR TRADE — Eico 425 scope and 360 sweep, very good condition; RCA radio 8BX5, 45 rpm RCA player, Kodak f6.3 with flash. Need Sams Photo-facts, res. cap. bridge, isolation transformer, selenium and transistor tester, etc. E. P. Sailer, 635 So. Orange, Lodi, Calif.

SELL OR TRADE — Superior TV30 sig. gen.; DeVry tech. 5" scope; Photo-facts. Need air horns with comp. and tank. Art Lowe, Box 3, Farmersburg, Ind.

FOR SALE — Citizens' band transceiver, super-het receiver, three way power supply self-contained, \$65. J. Coffield, 1731 West First St., Brooklyn 23, N. Y.

WANTED — Electrovoice speakers: one each T35, T25A, 6HD horn and Model 118 in excellent condition. Fred Butterfield, 1 Second St., Brooklawn, N. J.

SELL OR TRADE — Two Vocaline transceivers complete with ground plane antennas, or trade for Hickok 209A in very good cond. Paul F. Vick, Kershaw, S. C.

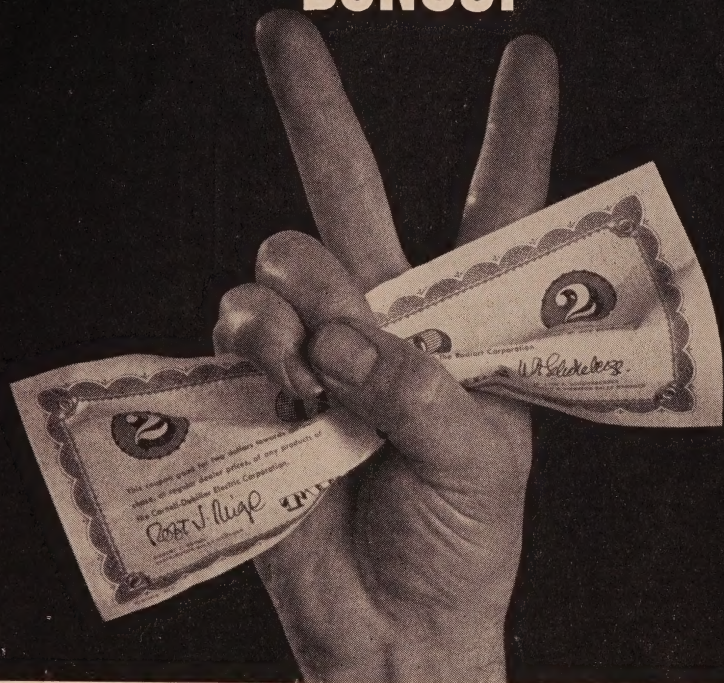
WANTED — Chassis RCA model 15X radio; car radio, new or used. Louis R. De Marco, Jr., 193 Pine St., New Haven 13, Conn.

SELL OR SWAP — 120 bass accordion, hardly used, and metal clarinet in good cond., for ham or test equip. Also want early issues of Popular Electronics. David Christensen, Box 303, St. Ansgar, Iowa.

TRADE — Ham transmitter parts for good U.S. or foreign stamps. V. Barker, Woodside Drive, Freeport, Ill.

FOR SALE — Gonset triband converter, \$25; ART-13 transmitter, \$35; Heath Q multiplier, \$8. All in good condition. William Hardin, 8407 Jenny Lind Dr., Louisville 19, Ky.

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For a limited time only, every CDR TV Rotor you buy carries a coupon on the carton that's good for \$2 towards the purchase, *at your regular prices*, of any Cornell-Dubilier or Radiart product. That's right! Now when you install a new CDR Rotor you get a double dividend: customer satisfaction for the bright, sharp pictures you've brought to their TV viewing; *and* two dollars worth

of any Consistently Dependable CD/E capacitor, Radiart vibrator, or any other product made by either of these two electronic-parts pioneers. This *extra* Promotion, celebrating CD/E's 50th Birthday, closes June 1, 1960, so see your CD/E Distributor today for complete details or write to Distributor Division, Cornell-Dubilier Electric Corporation, South Plainfield, New Jersey.

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4	NLW 40-3	40	3
4	NLW 10-15	10	15
3	NLW 50-15	50	15
3	NLW 100-15	100	15

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